Equational-intensional relative clauses with syntactic reconstruction[1]

Itai Bassi – *Massachusetts Institute of Technology*
Ezer Rasin – *Massachusetts Institute of Technology*

Abstract. Analyses of scope reconstruction typically fall into two competing approaches: 'semantic reconstruction', which derives non-surface scope using semantic mechanisms, and 'syntactic reconstruction', which derives it by positing additional syntactic representations at the level of Logical Form. Grosu and Krifka (2007) proposed a semantic-reconstruction analysis for relative clauses like *the gifted mathematician that Dan claims he is*, in which the relative head NP can be interpreted in the scope of a lower intensional quantifier. Their analysis relies on type-shifting the relative head into a predicate of functions. We develop an alternative analysis for such relative clauses that replaces type-shifting with syntactic reconstruction. The competing analyses diverge in their predictions regarding scope possibilities in head-external relative clauses. We use Hebrew resumptive pronouns, which disambiguate a relative clause in favor of the head-external structure, to show that the prediction of syntactic reconstruction is correct. This result suggests that certain type-shifting operations are not made available by Universal Grammar.

Keywords: relative clauses, scope, reconstruction, type-shifting, de dicto, intensional quantifiers, binding, resumptive pronouns.

1. Introduction

Our focus in this paper is on one kind of relative clauses (RCs) with an embedded intensional quantifier and a copular clause, analyzed in Grosu and Krifka (2007) and illustrated in (1). Following Grosu and Krifka (2007), we refer to such RCs as 'equational-intensional RCs'.

(1) The gifted mathematician that Dan claims he is should be able to solve this problem

The sentence in (1) has two readings which we will refer to as *de dicto* and *de re*. According to the *de dicto* reading, given Dan's claim that he is mathematically gifted, he should be able to solve this problem. On the less salient *de re* reading, there is a certain gifted mathematician, say Hilbert, who should be able to solve this problem; Dan claims that he is Hilbert.

The *de dicto* reading presents an apparent mismatch between the syntax and the semantics of (1). On the semantic side, the *de dicto* reading does not imply the existence of a gifted mathematician, but rather only that Dan claims to be one. This suggests that the world variable of the relative head *gifted mathematician* should be bound by the intensional quantifier *claim* in the logical representation of the *de dicto* reading of (1), as schematized in (2). On the syntactic side, on the other hand, the relative head *gifted mathematician* is not c-commanded by the intensional quantifier *claim* in the surface structure of (1). The challenge, then, is that

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the relative head *gifted mathematician* seems to be interpreted in a pre-movement position—a scope-reconstruction effect.

(2) $\forall \boldsymbol{w} \in \text{CLAIM}_{Dan,@}[\text{...gifted-math'}(\boldsymbol{w})\text{...}]$

where $\text{CLAIM}_{Dan,@}$ stands for the set of worlds compatible with Dan's claims in the utterance world

The literature offers two main approaches to scope reconstruction. The first approach places the burden of explanation on the syntax by interpreting the higher NP in a low ('reconstructed') position at the level of 'Logical Form' (LF) (Chomsky 1993; Romero 1998; Sauerland 1998, 2004; Fox 1999; Heim 2012, among others). We label this approach SYNR (for syntactic reconstruction). The second approach accounts for the mismatch by complicating the semantics using semantic operations such as type-shifting, which often take the surface syntactic structure as their input (Jacobson 1994; Cresti 1995; Rullmann 1995; Lechner 1998; Sharvit 1999; Ruys 2011, among others). We label this second approach SEMR (for semantic reconstruction).[2] The present paper compares the two main approaches to scope reconstruction—SYNR and SEMR—with respect to equational-intensional RCs like (1).

An analysis of the *de dicto* reading of equational-intensional RCs within SEMR was developed by Grosu and Krifka (2007) (henceforth G&K). Here is a sketch of their analysis. G&K take the matrix subject to denote an individual concept, a function from worlds to individuals. In particular, the subject denotes the function that maps each world compatible with Dan's claims to Dan, who is a gifted mathematician in that world (3).

(3) Individual-concept denotation of the subject
$[\![$the gifted mathematician Dan claims he is$]\!] =$
$\iota f_{\langle s,e\rangle}\big[dom(f)=\text{CLAIM}_{Dan,@} \wedge \underline{\forall w \in \text{CLAIM}_{Dan,@}}[\text{DAN}(w)=f(w) \wedge \underline{\text{gifted-math'}(w)}\big(f(w)\big)]\big]$

The main ingredient of G&K's compositional derivation of (3) is a semantic mechanism that has two functions: it type-lifts the relative head *gifted mathematician* from a predicate of individuals to a predicate of individual concepts, and it binds the world of evaluation of the relative head. The basic meaning of the relative head on this analysis is given in (4) and the type-shifted meaning is given in (5). The RC *that Dan claims he is* is assumed to involve abstraction over an individual-concept variable and has the denotation in (6).

(4) $[\![\text{gifted-mathematician}]\!]^{@} = \lambda x.\ x \text{ is a gifted-math' in } @$

(5) $\text{TS}([\![\text{gifted-mathematician}]\!]) = \lambda f_{\langle s,e\rangle}.\ \forall w \in dom(f)\big[[\![\text{gifted-mathematician}]\!]^{w}(f(w))\big]$

(6) $[\![\text{that Dan claims he is}]\!]^{@} = \lambda f_{\langle s,e\rangle}.\ \forall w \in \text{CLAIM}_{Dan,@}\big[\text{DAN} = f(w)\big]$

The RC and the type-shifted head are of the same type and can combine intersectively (7a) to derive the meaning in (7b).

[2]The labels SYNR and SEMR are borrowed from Keine and Poole (2017).

(7) a. $\underbrace{\text{TS}[\![\text{gifted-mathematician}]\!]}_{\text{type } \langle se,t\rangle}\underbrace{[\![\text{that Dan claims he is}]\!]}_{\text{type } \langle se,t\rangle}$

b. $\lambda f_{\langle s,e\rangle}.\ \forall w \in \text{CLAIM}_{Dan,@}\left[\text{DAN} = f(w)\right] \wedge$
$\forall w \in dom(f)\left[[\![\text{gifted-mathematician}]\!]^w(f(w))\right]$

In (7b), the world parameter of *gifted mathematician* is bound by $\forall w \in dom(f)$. On the assumption that *the* can pick up the smallest function in (7b) (for details see G&K as well as the appendix), we get the meaning of the entire subject in (3), in which the domain of the function f is $\text{CLAIM}_{Dan,@}$. The result is that the world parameter of *gifted mathematician* ends up being bound by *claim* without interpreting the relative head NP (or any other constituent) in a non-surface position.[3]

An alternative theory of the *de dicto* reading of (1) within SYNR will be developed in detail in section 2. The main ingredient of the proposed theory, assuming the Copy Theory of Movement (Chomsky 1993), is a syntactic representation where only the low (unpronounced) copy of the relative head is semantically interpreted, as schematized in (8). As for the semantics, the theory draws on the semantics of syntactic reconstruction in Heim (2012).

(8) LF: The ~~gifted-mathematician~~ that ... claim ... gifted-mathematician

As mentioned above, our goal is to compare the two competing approaches to scope reconstruction—SEMR and SYNR—with respect to equational-intensional RCs like (1). We do so in three steps. First, we develop the theory of the *de dicto* reading in equational-intensional RCs within SYNR (section 2). After developing the theory in section 2, we discuss a point of divergence in predictions between SEMR and SYNR with respect to equational-intensional RCs (section 3). The divergence concerns the availability of *de dicto* readings in head-external RCs. As we show in section 3, SEMR generates *de dicto* readings in head-external RCs, but SYNR without type-shifting does not. Finally, in section 4 we use Hebrew resumptive pronouns as a case study to test the divergent prediction presented in section 3. Hebrew resumptive pronouns are suitable for this task since they can disambiguate an RC in favor of the head-external structure, where the two approaches diverge. Extending an observation by Doron (1982), we show that *de dicto* readings are absent in the presence of resumptive pronouns. The absence of *de dicto* readings with resumptive pronouns is exactly what SYNR predicts, but it is surprising if type-shifting operations like (5) are made available by Universal Grammar.

[3] G&K's analysis is related to SEMR accounts of *functional readings* in questions and RCs, illustrated in (i), where a variable of type $\langle e\rangle$ (underlined) appears to be bound by a non-c-commanding quantifier (in bold).

(i) a. Which [picture of $\underline{\text{herself}_i}$] did **every girl**$_i$ submit? (Engdahl 1986)
b. The [relative of $\underline{\text{his}_i}$] that **every man**$_i$ likes best is his$_i$ mother (Geach 1964; Jacobson 1994, 2002)

Engdahl (1986) (for questions) and Sharvit (1999) and Jacobson (2002) (for RCs) posit a type-shifting operation along the lines of G&K's (5) that binds individual variables (rather than world variables) and shifts an NP into a predicate of functions of type $\langle e,e\rangle$ (rather than type-$\langle s,e\rangle$ functions). See Heim (2012) for an analysis of functional readings that uses syntactic reconstruction and forgoes type-shifting.

2. Syntactic Reconstruction

2.1. Preliminaries

In this section we develop the SYNR theory of the *de dicto* reading of (1), repeated in (9), focusing on the denotation of the matrix subject.

(9) [The gifted mathematician that Dan claims he is] should be able to solve this problem

Here are some of the differences between the SYNR theory we propose in this paper and G&K's SEMR theory. The first difference, which is not our focus in this paper, is the following. While SEMR is committed to an individual-concept denotation for the subject as in (3), SYNR can generate the *de dicto* reading both with an individual-concept denotation for the subject as in (3) and with the individual denotation in (10).

(10) Individual denotation of the subject[4]
$\iota x_e \left[\forall w \in \text{CLAIM}_{Dan,@}\left[x \text{ is a gifted-math' in } w \wedge x = Dan\right]\right]$
= Dan, who is a gifted math' in all worlds compatible with his claims

We bring up the compatibility of SYNR with (10) to simplify the presentation of the approach. It turns out that the compositional details of the individual denotation in (10) are simpler than those of the individual-concept denotation in (3), so we will present SYNR using (10) in what follows. For completeness, we provide the derivation of the individual-concept denotation in (3) under SYNR in the appendix, and we will show that the main prediction of SYNR we discuss in this paper is made with both denotations.

Our focus in this paper is on the differences between SEMR and SYNR that have to do with the mechanism responsible for scope reconstruction: first, the SYNR theory we propose assumes that the moved NP *gifted mathematician* is interpreted in a low (reconstructed) position at LF, as schematized above in (8); second, the proposed theory relies on the unavailability of the type-shifting operation posited by G&K. We stipulate that G&K's type-shifter in (5), repeated in (11) in its general form, is not made available by Universal Grammar.[5] In the present paper, we assume the stipulation in (11) without discussion and do not try to derive the absence of the type-shifter from deeper principles.

[4]The uniqueness requirement of the iota operator in (10) is met assuming that individuals are the same across worlds (Kripke 1980). Note that (10) is an oversimplified representation which ignores issues such as binding of individual variables into intensional contexts (Quine, 1956). We will stick to this oversimplified representation since, as far as we can tell, those issues can be resolved in ways that do not bear on the mechanism responsible for scope reconstruction (see, e.g., Percus and Sauerland 2003).

[5]G&K's SEMR analysis derives the *de dicto* reading through a combination of abstraction over individual-concept variables and type-shifting. Since both ingredients can be dispensed with under SYNR, excluding the SEMR derivation of the *de dicto* reading could also be achieved by banning abstraction over individual-concept variables (as an alternative to banning type-shifting). Defending that alternative seems to us like a non-trivial challenge given that traces can be arguments of predicates that arguably take individual-concept arguments (like *rise*), as in *the number of residents in this city is 250,000, a number that **rose** significantly in the past decade*, so we do not pursue that alternative here (see Montague, 1973 and later literature for discussion of predicates of individual concepts). In addition, to our knowledge G&K's type-shifter has not been used elsewhere in the literature.

(11) STIPULATION REGARDING TYPE-SHIFTING
Universal Grammar does not make available the following type-shifter:

$$\mathrm{TS}(P_{\langle s,et\rangle}) = \lambda f_{\langle s,e\rangle}.\ \forall w \in dom(f)\left[P(w)(f(w))\right]$$

Assuming (11), we proceed to develop the theory behind (10) under SYNR by first presenting our assumptions about the syntax in 2.2. Then, in 2.3, we present the semantic composition of the subject, followed by the combination of the subject with the rest of the sentence in 2.4.

2.2. Syntax

Our proposal for the LF of the subject is given in (12). We assume a 'head-raising' derivation of the RC, where the relative head NP is generated inside the RC and undergoes movement to its surface position (Schachter 1973; Vergnaud 1974; Bhatt 2002, among others). The high (pronounced) copy of the head NP is deleted and its low copy is converted into a definite description using the mechanism of Trace Conversion (Fox 2002, Sauerland 2004, Heim 2012).

(12) The ~~GM~~ λx_e Dan claims$_{@}$ λw [he is $\underbrace{\text{THE [GM}_w\text{ [IDENT } x_e\text{]]}}_{\text{Converted trace}}$]

The syntactic derivation of (12) proceeds as in (13). First, the RC *Dan claims that he is a gifted mathematician* is constructed by repeated application of external merge.[6] Then, the NP *gifted mathematician* is copied through internal merge, which we take to insert a binder below the copied NP (Heim and Kratzer 1998). Next, the definite article is externally merged. Trace Conversion converts the lower copy into a definite description and the lower determiner is deleted (cf. Heim 2012). Then, the higher NP is deleted. Finally, two world variables, which we assume to be represented in the syntax (see, e.g., Cresswell 1990), are inserted and saturate the world argument of the predicates *claims* and *gifted mathematician*.

(13) LF derivation (cf. Heim 2012):

Construct TP:	Dan claims λw [he is a GM]
Internal-merge NP:	GM λx_e Dan claims λw [he is a GM]
External-merge *the*:	the GM λx_e Dan claims λw [he is a GM]
Trace conversion + ~~Det~~:	the GM λx_e Dan claims λw [he is ~~a~~ THE [GM IDENT x_e]]
Delete higher NP:	the ~~GM~~ λx_e Dan claims λw [he is THE [GM IDENT x_e]]
Insert world pronouns:	the λx_e Dan claims$_{@}$ λw [he is THE [GM$_w$ IDENT x_e]]

[6]Our choice of the indefinite article as the lower determiner is arbitrary. Since that determiner eventually gets deleted, other choices would not have made a difference.

2.3. Semantics

We now show that the LF in (12) results in the desired individual denotation of the subject in (10), repeated here:

(14) $\iota x\big[\forall w \in \text{CLAIM}_{Dan,@}[x \text{ is a gifted-math' in } w \wedge x = Dan]\big]$
= Dan, who is a gifted math' in all worlds compatible with his claims

The interpretation procedure makes important use of the mechanism of presupposition projection, following Heim (2012). We present the central steps of the interpretation of the LF in (15) going bottom-up.

(15) The λx_e Dan_2 $\text{claims}_@$ λw [he_2 is THE [GM_w IDENT x_e]]

For the first step, THE and IDENT are defined as in (16) and (17). The converted trace has the interpretation in (18).

(16) $[\![\text{THE}]\!] = \lambda P_{\langle e,t\rangle} : \exists!x[P(x)].\iota x[P(x)]$

(17) $[\![\text{IDENT}]\!] = \lambda x.\lambda y.\ x = y$

(18) $[\![\text{THE [GM}_w \text{ IDENT } x]]\!]^g$ is defined only if
$g(x)$ is a gifted-math' in $g(w)$;
where defined, $[\![\text{THE [GM}_w \text{ IDENT } x]]\!] = g(x)$

Our entries for the copula and *claim* are given in (19) and (20). *claim* projects the presuppositions of its complement universally, as indicated by the statement that immediately follows the colon in (20). Thus, the presupposition introduced in (18) projects universally as in (21).

(19) $[\![\text{be}]\!] = [\![\text{IDENT}]\!] = \lambda x.\lambda y.\ x = y$

(20) $[\![\text{claim}]\!] = \lambda w.\lambda p_{\langle s,t\rangle}.\lambda x : \forall w' \in \text{CLAIM}_{x,w}[w' \in dom(p)].\ \forall w' \in \text{CLAIM}_{x,w}[p(w') = 1]$
where $\text{CLAIM}_{x,w}$ is the set of worlds compatible with x's claims in w

(21) $[\![\text{Dan}_2 \text{ claims}_@ \ \lambda w \text{ he}_2 \text{ is } [\text{THE [GM}_w \text{ IDENT } x]]]\!]^g$ is defined only if
$\forall w \in \text{CLAIM}_{Dan,@}[g(x) \text{ is a gifted-math' in } w]$;
where defined, it equals 1 iff $\forall w \in \text{CLAIM}_{Dan,@}[Dan = g(x)]$

The next step, in (22), is abstraction over the variable x. For this step, notice that we can simplify the assertive component of (21) and replace $\forall w \in \text{CLAIM}_{Dan,@}[Dan = g(x)]$ with the equivalent statement $[Dan = g(x)]$ (assuming that $\text{CLAIM}_{Dan,@}$ is not empty). The presupposition in (21) continues to project, this time by making the result of the abstraction a partial function defined only for individuals that satisfy the presupposition. (22) denotes the characteristic function of the singleton containing Dan, who is (presupposed to be) a gifted mathematician in each of his CLAIM worlds.

(22) $[\![\lambda x_e\ \text{Dan}_2\ \text{claims}_@\ \lambda w\ \text{he}_2\ \text{is}\ [\text{THE}\ [\text{GM}_w\ \text{IDENT}\ x]]]\!] =$
$\lambda x_e : \forall w \in \text{CLAIM}_{Dan,@}[x \text{ is a gifted-math' in } w]$
$. \ Dan = x$

The combination of (22) with the definite article yields the denotation of the subject in (23), as desired.

(23) $[\![\text{The}\ \lambda x_e\ \text{Dan}_2\ \text{claims}_@\ \lambda w\ [\text{he}_2\ \text{is}\ \text{THE}\ [\text{GM}_w\ \text{IDENT}\ x_e]]]\!]$
$= \iota x\big[x = Dan \wedge \forall w \in \text{CLAIM}_{Dan,@}[x \text{ is a gifted-math' in } w]\big]$
= Dan, who is a gifted math' in all worlds compatible with his claims

Since *gifted mathematician* is interpreted in the scope of *claim*, the reconstruction effect is achieved using syntactic reconstruction and without the type-shifter in (11).

2.4. Combination of the subject with the rest of the sentence

The combination of the subject with the rest of the sentence proceeds in the usual way, as in (24). For concreteness, we assume that the subject reconstructs below *should* at LF as in (24a). The structure in (24a) results in the denotation in (24b).[7]

(24) The gifted mathematician Dan claims he is should be able to solve this problem
a. LF: $\text{Should}_@\ \lambda w\ \big[$ [the $\lambda x \ldots$ GM $\ldots$] [be-able$_w$ to solve this problem] $\big]$
b. $\forall w' \in \text{SHOULD}_@\big[\iota x\big[x = Dan \wedge \forall w \in \text{CLAIM}_{Dan,@}[x \text{ is a gifted-math' in } w]\big]$
is able to solve this problem in $w'\big]$

3. A divergent prediction

In this section, we show that SYNR ties the availability of the *de dicto* reading in equational-intensional RCs to the syntactic structure of the RC, whereas SEMR does not. Importantly, SYNR and SEMR diverge in their predictions regarding the availability of the *de dicto* reading with *head-external* derivations of the RC, where the relative head is generated outside of the RC. Such derivations include the classical derivation where a null operator undergoes Ā-movement (Chomsky, 1977), the so-called 'matching' derivation where an NP undergoes Ā-movement and gets deleted (Chomsky 1965; Sauerland 1998), and, as we will see later, derivations with no Ā-movement inside the RC whatsoever. In particular, as we now show, SYNR but not SEMR makes the prediction in (25).

(25) **Prediction of SYNR**: the *de dicto* reading in an equational-intensional RC will be blocked when the RC is unambiguously head-external

[7] On the most salient interpretation of (24), Dan would be able to solve the problem under normal circumstances that would arise assuming that his claims are true. That is, the domain of *should* seems to be restricted to a subset of the worlds compatible with Dan's claims. See Kratzer (2012) for a theory of modality that can derive this restriction contextually by appealing to the contextually-available set $\text{CLAIM}_{Dan,@}$. We leave out the details for reasons of space.

To see why SYNR does not generate the *de dicto* reading with head-external RCs, consider first the situation of an RC that denotes a predicate of individuals—in fact, an intensionalized predicate of individuals (as in our analysis in section 2). Since the relative head has not undergone movement, it must be interpreted in its surface position, above the intensional quantifier. The *de dicto* reading is not derived because the world argument of the head is not bound by the quantifier. This scenario is schematized in (26), where the world argument @ and the binder are given in bold.

(26) $\underbrace{[\![\text{gifted-math'}_{\mathbf{@}}]\!]}_{\text{type } \langle s,et\rangle}\underbrace{[\![\lambda x \text{ Dan claims } \boldsymbol{\lambda w}...]\!]}_{\text{type } \langle s,et\rangle}$ (*de dicto* not generated)

Consider now the alternative situation of an RC that denotes a predicate of individual concepts (as in the SYNR analysis of the *de dicto* reading in the appendix). Given the assumption of SYNR in (11)—namely, given that predicates of individuals cannot be type-shifted into predicates of individual concepts, interpreting the relative head outside of the RC would result in a type-mismatch between the relative head and the RC. On this scenario, which is schematized in (27), the structure would be uninterpretable.

(27) $\underbrace{[\![\text{gifted-math'}_{@}]\!]}_{\textbf{type } \langle \boldsymbol{s,et}\rangle}\underbrace{[\![\lambda f \text{ Dan claims } \lambda w...]\!]}_{\textbf{type } \langle \boldsymbol{se,t}\rangle} = ??$ (type-mismatch; nothing generated)

In contrast to SYNR, SEMR does not make the prediction in (25). Whether the relative head has moved from an RC-internal position or not, it can be type-shifted into a predicate of functions and get interpreted in the scope of the embedded intensional quantifier.

Our observations regarding the predicted dependency between scope and RC structure under SYNR are not new. They have been explored in various works including Sauerland (1998), Bhatt (2002), Fox (2002), Heycock (2005), and Hulsey and Sauerland (2006). Previous research has also offered diagnostics for head-external RCs such as Condition C and extraposition that might be used to test the prediction in (25) (see especially Hulsey and Sauerland 2006). In the next section, we use resumption in Hebrew—a diagnostic for head-external RCs that allows us to test the prediction in (25) using sentences that differ only minimally from the RCs discussed by G&K, and where the judgments regarding the availability of the *de dicto* reading are clear.

4. Case study: Hebrew resumptive pronouns

In this section we present resumptive pronouns (RPs) in Hebrew as a diagnostic for head-external RCs, and show, using that diagnostic, that the prediction of SYNR for equational-intensional RCs in Hebrew is correct. We start, in 4.1, by providing background on the distribution and interpretation of RPs in Hebrew. Then, in 4.2, we present a theory of RPs that derives their distribution and interpretation from the assumption that RPs inhabit head-external RCs. Finally, in 4.3, we use Hebrew RPs to test the divergent prediction of SYNR and SEMR regarding equational-intensional RCs in Hebrew. (Readers who are familiar with resumption as a diagnostic for head-external structure may wish to proceed directly to 4.3.)

4.1. Background: the distribution and interpretation of Hebrew resumptive pronouns

RPs are pronouns that appear in unbounded dependency constructions such as RCs, questions, and clefts, in positions where we would otherwise expect a gap. The Hebrew RC in (28) illustrates: a pronoun optionally occurs in direct object position, where other languages, like English, must use a gap.[8] We focus here on Hebrew RPs in RCs which, in simple RCs, alternate with a gap.[9]

(28) ze ha-sefer še-karati ∅/**oto** etmol
this the-book that-I.read **∅/it** yesterday
'This is the book that I read yesterday'

The literature on RPs has argued that RPs like the one in (28) are incompatible with movement (Chomsky 1977, McCloskey 1979, McCloskey 1990, Borer 1984, Shlonsky 1992, among others). Evidence that movement is not involved includes the insensitivity of RPs to islands, as well as environments where RPs are not interpreted like gaps, which suggests they are not merely phonological spell-outs of gaps (Doron 1982, Sichel 2014).

The examples in (29) illustrate that Hebrew RPs are obligatory in island contexts, using a complex NP island in (29a) and an adjunct island in (29b).

(29) *Evidence for non-movement #1: insensitivity to islands*

a. *Direct object RP, complex NP island*
ze ha-sefer še-ani makir et ha-iša še-kar'a **oto/*∅**
this the-book that-I know ACC the-woman that-read **it/*∅**
'This is the book that I know the woman who read it'

b. *Direct object RP, adjunct island*
ze ha-sefer še-ani sameax biglal še-karat **oto/*∅**
this the-book that-I happy because that-you-read **it/*∅**
'This is the book that I'm happy because you read it'

To demonstrate that RPs are not interpreted like gaps, consider the following Hebrew idiom:

(30) litfor tik le-X
to.sew briefcase for-X
'to frame X for a crime' (lit. 'to sew a briefcase for X')

[8]Resumption is considered to be part of the grammar of Hebrew. Theories of resumption distinguish grammatical RPs from 'intrusive RPs' in languages like English, which have a different behavior. As opposed to grammatical RPs, intrusive RPs only occur in island contexts or deeply-embedded contexts, and there is evidence suggesting that they do not bring island structures to full acceptability (Alexopoulou and Keller 2007).

[9]Hebrew also has RPs that never alternate with a gap (e.g., following a preposition) which behave differently (Sichel 2014). Since such RPs will not help us distinguish between SYNR and SEMR, we ignore them here, and they should be taken to be excluded whenever RPs are referred to in the main text.

An RC can be formed with the noun *tik* 'briefcase' as its head. In RCs headed by 'briefcase', the idiomatic interpretation is unavailable precisely in the presence of an RP, as shown in (31): in (31a), where an RP is optional, a gap but not an RP is consistent with the idiomatic interpretation, as observed by Sichel (2014); in (31b), an RP is obligatory and the idiomatic interpretation is unavailable.

(31) *Evidence for non-movement #2: RPs are not interpreted like gaps*

a. *RP blocks idiomatic interpretation, non-island context* (Sichel, 2014)
ha-tik še-tafru **#oto/∅** la-sar haya kašur le-nadlan
the-briefcase that-they.sewed **#it/∅** for-the-minister was related to-real.estate
'The crime that they framed the minister for was related to real estate.'

b. *RP blocks idiomatic interpretation, island context*
ha-tik še-ani sameax biglal še-tafru **oto/*∅** la-sar
the-briefcase that-I happy because that-they.sewed **it/*∅** for-the-minister
haya kašur le-nadlan
was related to-real.estate
Intended: 'I'm happy because they framed the minister for a crime related to real estate.'

Next, we show how the distributional and interpretive properties of RPs discussed in this section follow from a theory of resumption on which RPs inhabit head-external RCs.

4.2. Theory of the distribution and interpretation of resumptive pronouns

Rasin (2017), following McCloskey (2002) and Adger and Ramchand (2005) (cf. Sichel 2014), proposed an account of the distributional and interpretive properties of Hebrew RPs according to which RPs unambiguously inhabit head-external RCs that are formed without movement.

On this account, the derivation of a non-movement head-external RC proceeds as in (32). First, a TP is constructed with an ordinary pronoun. Then, a λ-binder is externally merged from the lexicon and the pronoun is abstracted over without movement. (On this view, the existence of a λ-binder in the lexicon of Hebrew is what distinguishes Hebrew from languages like English, where similar resumed relatives are unavailable.) Finally, the relative head NP is externally merged.

(32) Derivation of a head-external structure for [book that Miri read it]

Construct TP:	$[_{TP}$ Miri read it$_1$]
External-merge λ-binder:	$[_{CP}$ λ_1 Miri read it$_1$]
External-merge *book*:	$[_{NP}$ book λ_1 Miri read it$_1$]

On Rasin's 2017 account, head-raising and head-external (non-movement) RCs co-exist in Hebrew. Head-raising RCs are formed with movement which leaves a gap, whereas head-external

RCs, which are derived as in (32), have an ordinary pronoun. The co-existence of these two RC structures in Hebrew accounts for the distribution of RPs as follows: in non-island contexts, RPs are optional because both structures are available; in island contexts, movement (hence head-raising) is unavailable, so the RP is obligatory. The interpretive effects of RPs follow as well. Consider again the blocking of idiomatic interpretations in (31). Assume, following the literature on the syntax of idioms, that a syntactic locality restriction requires a low copy of the relative head in order to achieve the idiomatic interpretation (e.g., Marantz 1997 and references cited there). The presence of an RP indicates that movement of the relative head has not taken place. This means that there is no low copy of the relative head, and thus, on the assumption regarding syntactic locality, that the idiomatic interpretation is unavailable when an RP is present. Now that we have an independently-supported theory of RPs as a diagnostic for head-external RCs, we can proceed to test the prediction presented in section 3.

4.3. Resumptive pronouns block the *de dicto* reading

Doron (1982) discovered that Hebrew RPs block *de dicto* readings in RCs with intensional transitive verbs like *seek*. Here we show that her discovery extends to equational-intensional RCs, as predicted by SYNR but not by SEMR.

The Hebrew counterpart of G&K's example with a gap is compatible with both the *de dicto* and the *de re* interpretations, as in English:[10]

(33) *A gap allows the de dicto reading, non-island context*

ha-matematikai ha-mexunan$_i$ še-ata toen še-ata t_i amur lehacliax liftor
the-mathematician the-gifted$_i$ that-you claim that-you t_i should be.able to.solve
et ha-baaya be-kalut
ACC the-problem in-easiness
'The gifted math' that you claim you are should be able to solve the problem easily'
(*de re*, *de dicto*)

An RP is optional in the position of the gap. Crucially, when it is present, the *de dicto* reading is blocked (34).

(34) *An RP blocks the de dicto reading, non-island context*

ha-matematikai ha-mexunan$_i$ še–ata toen še-ata **hu**$_i$ amur lehacliax
the-mathematician the-gifted$_i$ that-you claim that-you **him**$_i$ should be.able
liftor et ha-baaya be-kalut
to.solve ACC the-problem in-easiness
'The gifted math' that you claim you are should be able to solve the problem easily'
(*de re*, **de dicto*)

[10]For our Hebrew sentences we use a second-person pronoun as the subject of the embedded copular sentence. For some reason, a proper name sounds unnatural in this construction and the third-person pronoun is degraded when followed by an RP, so we were not able to use them.

We tested (34) with two contexts, one that is compatible with the *de re* reading and one that is not (35). Speakers reported a contrast between the contexts: (34) sounded more natural to them in the *de-re*-compatible context (35a) than in the *de-re*-incompatible context (35b)[11], suggesting that (34) is only true given the *de-re*-compatible context.[12]

(35) Contexts for (34)

a. *de-re*-compatible context: Rina is a participant in a trivia game show. In each stage of the game, a person hiding behind a curtain claims to be a historically famous mathematician. Rina's task is to guess the mathematician's identity by presenting the person with statements to which the person responds 'True' or 'False'. In one stage of the game, Leibniz is the mathematician whose identity Rina is supposed to guess. She writes on a piece of paper: "Problem: Prove that the real numbers are uncountable". She knows that only mathematicians born after 1874, the year in which the first such proof was provided, would be able to solve the problem easily. She presents the paper and says: "True or False?." She then says (34).

b. *de-re*-incompatible context: Rina is a recruiter for a high-tech company which is looking for a new mathematician. She interviews Dan for the job. During the interview, Dan tells Rina that he is mathematically gifted. To test his claim, Rina presents him with a problem that only truly gifted mathematicians can solve. She then says (34).

Similarly, an RP in an island construction blocks the *de dicto* reading (the sentence in (36) is unacceptable in a *de-re*-incompatible context, a variant of (35b) where Dan claims that he is mathematically gifted prior to being invited for an interview and his claim is the reason for the invitation):

(36) *An RP blocks the de dicto reading, island context*

ha-matematikai ha-mexunan$_i$ še-hizmanu otxa [biglal še–ata toen
the-mathematician the-gifted$_i$ that-we.invited you [because that-you claim
še-ata **hu**$_i$/*t_i] amur lehacliax liftor et ha-baaya be-kalut
that-you **him**$_i$/*t_i] should be.able to.solve ACC the-problem in-easiness
Intended *de dicto*: 'We invited you because you claim that you are mathematically gifted' (*de re*, **de dicto*)

[11] We presented the sentences in (34) and (36) by reading them out loud with intonational prominence on the RP. Shifting the prominence to *toen* 'claim' improved the acceptability of (34) in the *de-re*-incompatible context but did not improve the acceptability of (36) in the same context. At present, we are not sure how to make sense of the effect of prominence-shift on the judgments regarding (34). As far as we can tell, however, that effect does not undermine our argument: a contrast between *de re* and *de dicto* is still found in (34) with prominence on the RP and in (36) regardless of the intonational pattern.

[12] The Hebrew copula is phonologically identical to a pronoun. One might wonder whether *hu* 'him' in our examples can be analyzed as a copula followed by a trace. We note that such an analysis would not account for the *de re*/*de dicto* asymmetry on either theory and that it is impossible as an analysis of *hu* 'him' in (36) to begin with, since a trace is unavailable in an island construction. Furthermore, to our own judgment the *de re*/*de dicto* asymmetry in (34) and (36) remains the same if we change the equational sentence to the past tense (*ata hayita **hu*** '(that) you used.to.be **him**'), where the third-person pronoun is no longer identical to the copula.

Given that the RPs above inhabit head-external relatives, and given the reasoning described in section 3, the distribution of *de dicto* readings in (33)-(36) falls out under SYNR without any special assumptions. SEMR over-generates *de dicto* readings in (34) and (36) since it is not sensitive to the structure of the RC. Minimally, SEMR would require additional constraints to block those readings. At present, we have not been able to formulate constraints (including constraints on the semantic type of pronouns) that would block the *de dicto* readings in (34) and (36) without under-generating elsewhere, though we leave a more detailed review of possible responses within SEMR to a separate occasion.

5. Conclusion

We have shown that SYNR (but not SEMR) predicts that the *de dicto* reading in equational-intensional RCs should be unavailable with unambiguously head-external RCs. We have also shown that Hebrew RPs, which disambiguate an RC in favor of the head-external structure, block the *de dicto* reading. This result is predicted by SYNR, but it is surprising under theories that allow for the type-shifter proposed by G&K.

Our result raises a few questions that we have not answered in this paper. As mentioned in section 3, other diagnostics for head-external RCs have been proposed in the literature, such as Condition C and extraposition. SYNR predicts the *de dicto* reading to disappear in those cases as well, and that prediction remains to be tested. Another question concerns intensional RCs that are not equational, such as *the dog that Mary seeks*, with the intensional operator *seek* and without an embedded copular sentence. The present paper focused on equational-intensional RCs, whose semantics—if our analysis is correct—we understand. We leave open the question of whether the proposed analysis can extend to intensional RCs that are not equational.

Our claim that SYNR but not SEMR derives the *de dicto* reading in equational-intensional RCs is consistent with hybrid approaches to scope reconstruction according to which some semantic-reconstruction mechanisms are available alongside syntactic reconstruction (Lechner 1998, Sharvit 1998, Keine and Poole 2017). The literature on SEMR has proposed various semantic mechanisms for scope reconstruction; if our claim is correct, it merely suggests that one such mechanism is unavailable: type-shifting from predicates of individuals to predicates of individual concepts. In the present paper, we made the stipulation—repeated below in (37)—that this type-shifting operation is not made available by Universal Grammar. Our result raises the question of whether this unavailability can be derived from deeper principles, a question that at present we leave open.

(37) STIPULATION REGARDING TYPE-SHIFTING
Universal Grammar does not make available the following type-shifter:

$$\mathrm{TS}(P_{\langle s,et\rangle}) = \lambda f_{\langle s,e\rangle}.\ \forall w \in dom(f)\left[P(w)(f(w))\right]$$

A. Appendix: An individual-concept analysis

A.1. Analysis of the subject

In section 2 we mentioned that G&K's individual-concept denotation of the subject, repeated in (38), can be generated with syntactic reconstruction and without type-shifting. This appendix provides the relevant details.

(38) Individual-concept denotation of the subject (repeated from (3))
$[\![$the gifted mathematician Dan claims he is$]\!] =$
$\iota f_{\langle s,e\rangle}\left[dom(f)=\text{CLAIM}_{Dan,@} \wedge \forall w \in \text{CLAIM}_{Dan,@}\left[\text{DAN}(w)=f(w) \wedge \text{gifted-math'}(w)\big(f(w)\big)\right]\right]$

The main difference between the individual-concept version of SYNR presented here and the individual version presented in section 2 is that the semantics here involves abstraction over individual-concept variables as opposed to individual variables.

The LF we assume for the subject is given in (39). The functional variable f of type $\langle s,e\rangle$ is abstracted over and applies to a world variable w which is itself bound by λw.

(39) The $\lambda f_{\langle s,e\rangle}$ Dan_2 $\text{claims}_@$ λw [he_2 is THE [GM_w IDENT $f(w)$]]

As in section 2, we focus on the central steps of the interpretation procedure going bottom up.

The node $[f(w)]$ denotes the individual that f returns for w, and is defined only if f is defined for w (40). The converted trace in (41) introduces the additional presupposition that $f(w)$ is a gifted mathematician in w.

(40) $[\![f(w)]\!]^g$ is defined only if
$g(w) \in dom(g(f))$;
where defined, $[\![f(w)]\!]^g = g(f)(g(w))$

(41) $[\![$THE [GM_w IDENT $f(w)$]$]\!]^g$ is defined only if
$g(w) \in dom(g(f))$ and $g(f)(g(w))$ is a gifted mathematician in $g(w)$;
where defined, $[\![$THE [GM_w IDENT $f(w)$]$]\!]^g = g(f)(g(w))$

The next steps of the derivation before abstracting over f proceed along the same reasoning as in section 2 and need not be repeated here. After abstraction, the denotation of the RC is as follows:

(42) $[\![\lambda f_{\langle s,e\rangle}$ Dan_2 $\text{claims}_@$ λw [he_2 is THE [GM_w IDENT $f(w)$]]$]\!] =$
$\lambda f_{\langle s,e\rangle}$: $\forall w \in \text{CLAIM}_{Dan,@}[w \in dom(f)$ and $f(w)$ is a gifted-math' in $w]$.
$\forall w \in \text{CLAIM}_{Dan,@}[Dan = f(w)]$

(42) denotes the set of functions of type $\langle s,e\rangle$ which are defined at least for all of Dan's CLAIM worlds and which map each of Dan's CLAIM worlds to Dan, who is (presupposed to be) a gifted

mathematician in those worlds. One function in that set is (43), the function that satisfies the condition in (42) whose domain is equal to $\text{CLAIM}_{Dan,@}$. This function is the desired denotation of the subject (38).

(43) $\iota f\big[dom(f) = \text{CLAIM}_{Dan,@} \wedge \forall w \in \text{CLAIM}_{Dan,@}[f(w) = Dan \wedge f(w) \text{ is a gifted-math' in } w]\big]$

In addition to (43), the set in (42) includes any other function that satisfies the condition in (42) whose domain properly contains $\text{CLAIM}_{Dan,@}$. Since the definite article requires a singleton set as its argument and (42) includes multiple functions, it cannot apply to (42). The rest of the composition follows G&K, who propose to restrict the set in (42) to a singleton set that only contains (43). They define the minimization operation in (44) which picks up the smallest function from a set of functions.

(44) Let S be a set of functions. Then $min(S) = \big\{f \in S : \forall g \in S[g \subseteq f \rightarrow g = f]\big\}$

Applying minimization to (42) picks up the right singleton set:

(45) $$\begin{aligned} min\big((42)\big) &= \big\{f \in (42) : \forall g \in (42)[g \subseteq f \rightarrow g = f]\big\} \\ &= \big\{f \in (42) : dom(f) = \text{CLAIM}_{Dan,@}\big\} \\ &= \big\{(43)\big\} \end{aligned}$$

Now the definite article can apply to $min\big((42)\big)$ to derive the desired denotation:

(46) $[\![\text{the}]\!]\big(min(42)\big) =$
$\iota f\big[dom(f) = \text{CLAIM}_{Dan,@} \wedge \forall w \in \text{CLAIM}_{Dan,@}[f(w) = Dan \wedge f(w) \text{ is a gifted-math' in } w]\big]$

In words, this function is the unique function from Dan's CLAIM worlds to Dan, who is a gifted mathematician in those worlds. This is the same meaning G&K derive for *the gifted mathematician that Dan claims he is*, but using different compositional techniques.

A.2. Combination with the rest of the sentence

For the combination of the subject with the rest of the sentence, we assume that the subject is reconstructed below *should* at LF, and that it takes as an argument a world variable bound by *should*, in (47a). The final denotation is in (47b).

(47) The gifted mathematician Dan claims he is should be able to solve this problem
a. LF: $\text{Should}_@\ \lambda w\ \big[$ [the λf … GM … $]_w$ [be-able$_w$ to solve this problem] $\big]$
b. $\forall w \in \text{SHOULD}_@[f(w)$ is able to do solve the problem in $w]$,
where f is the denotation of the subject (given in (46)),
and $\text{SHOULD}_@$ is the set of worlds quantified over by *should*

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